

CONSTRUCTION OVERLAY COMPOSITION AND WALL STRUCTURE

BACKGROUND OF THE INVENTION

Cross-Reference to Related Application

5 This application is a divisional of co-pending Application Serial No. 10/025,831, filed Dec. 19, 2001, which claims priority to provisional application Serial No. 60/256,881, filed December 20, 2000, "Wall System Composition and Structure," which are commonly owned with the present invention and which are incorporated herein by reference.

Field of the Invention

10 The present invention relates to construction compositions, systems, and methods and, more particularly, to such compositions, systems, and methods for walls.

Description of Related Art

15 Concrete is the most widely used construction material in the world at present, comprising portland cement, water, fine and coarse aggregates, and a small amount of air. Portland cement is a mixture of tricalcium silicate, tricalcium aluminate, and dicalcium silicate, with small amounts of magnesium and iron compounds and sometimes gypsum.

20 Concrete mixtures are usually specified in terms of the dry-volume ratios of cement, sand, and coarse aggregates; for example, a 1:2:3 mixture consists of one part cement, two parts sand, and three parts coarse aggregate by volume. These proportions are variable for producing desired properties, such as strength and durability. The amount of water added is about 1–1.5 times the volume of the cement.

Concrete may be cast in place, prefabricated, or sprayed onto a surface using the shotcrete method. When concrete is sprayed from both sides onto a lattice of steel posts woven with bands of steel and paper, it is referred to as *gunnite*.

Cement, however, is not an environmentally neutral material. In the manufacture of cement, carbon dioxide is released into the atmosphere, and cement kilns burn hazardous waste, being a source of dioxins and mercury emissions into the atmosphere. Cement is an energy-intensive construction material, and its production produces malignant particulate matter, a presumptive cause of increased rates of cancer, asthma, lung disease, and skin disease in cement workers. Cement also pollutes water, with wash water from ready-mix plants highly alkaline and containing toxic cement kiln dust.

Kellert (U.S. Pat. No. 3,676,973) teaches the spraying of concrete onto a wire-screen-enmeshed insulation panel for modular building construction. Artzer (U.S. Pat. No. 4,226,067) discloses a lightweight structural panel comprising a plastic filler reinforced by wire lattice structures, compressed, and coated with a substance such as concrete or plastic. Chun (U.S. Pat. No. 4,253,288) describes a panel formed of wire meshes joined by wires and backing, insulation material sprayed onto the panels, and wall covering applied over the insulation. Kavanaugh (U.S. Pat. No. 4,288,962) teaches the spraying of polyurethane foam between I-beam flanges and then applying a fiberglass-cement mixture to form a surface. Hammond (U.S. Pat. No. 5,921,046) discloses a panel comprising a foam core with a thin coating of plastic resin or acrylic and portland cement for structural rigidity.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a construction composition that is low cost and aesthetically pleasing.

5 It is a further object to provide such a composition that incorporates indigenous materials.

It is another object to provide such a composition that is not labor-intensive to install.

It is an additional object to provide a structure incorporating the construction composition.

It is yet a further object to provide a method of making a construction composition.

10 It is yet another object to provide a method of making a structure incorporating the construction composition.

It is yet an additional object to provide a composition and method for recycling flyash into a useful construction composition.

It is yet also an object to provide compositions for slab and tile materials.

15 These and other objects are achieved by the present invention, a construction composition consisting essentially of soil, from about 12 to about 14 parts; water, from about 3 to about 4 parts; flyash, from about 2 to about 4 parts; and cement, from about 1 to about 2 parts.

20 The invention also includes a wall structure comprising a frame structure that comprises a plurality of spaced-apart frame elements and a support structure affixed to the spaced-apart elements to form an interior space. A core material resides within the support structure interior space, and the above-described overlay composition is applied to an exterior surface of the support structure.

The invention further includes a method of constructing a building element comprising the steps of erecting a frame structure comprising a plurality of spaced-apart frame elements and affixing a support structure to the frame elements to form an interior space. A core material is inserted into the support structure interior space, and the overlay composition is applied to an exterior surface of the support structure.

The invention additionally comprises embodiments of the composition for use in slabs and tiles.

The composition of the present invention uses 20-50% of the total amount of cement required in standard concrete mixtures known in the art.

The features that characterize the invention, both as to organization and method of construction, together with further objects and advantages thereof, will be better understood from the following description used in conjunction with the accompanying drawing. It is to be expressly understood that the drawing is for the purpose of illustration and description and is not intended as a definition of the limits of the invention. These and other objects attained, and advantages offered, by the present invention will become more fully apparent as the description that now follows is read in conjunction with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross-sectional view of an exemplary wall construction of the present invention.

FIG. 2 is a lateral, partially cutaway, view of the wall construction of FIG. 1.

FIG. 3 is a cross-sectional view of an alternate wall construction.

FIG. 4 is a perspective, partially cutaway, view of a third embodiment of the invention.

FIG. 5 is a cross-sectional view of a fourth wall construction.

5 **FIG. 6** is an end-plan perspective view of a partially enclosed, partially cutaway fifth wall construction.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

10 A description of the preferred embodiments of the present invention will now be presented with reference to FIGS. 1–6. It should be noted that the following embodiments are directed to wall structures, compositions therefor, and methods of making same; however, it will be understood by one of skill in the art that other constructions and building elements may be contemplated without departing from the scope of the invention.

15 The construction composition of the present invention, which comprises a fortified adobe-type composition, consists essentially of soil, from about 12 to about 14 parts; water, from about 3 to about 4 parts; flyash, from about 2 to about 4 parts; and cement, from about 1 to about 2 parts. In a most preferred embodiment for use on walls, the proportions are, in vol %: silver fines, 29.8; brown fines, 29.8; water, 23.2; flyash (class F), 12.4; and cement (type I-II portland), 2.8. Entrapped air accounts for 2 vol %. The water-
20 to-cementitious ratio is 0.65, and the aggregate-to-cementitious ratio is 4.33. For batching, mixing water should be added to obtain a slump between 2 and 3 inches. The measured

properties of this mix are: slump, 2–3 inches; compressive strength, 1000 psi; unit weight, 133.0 pcf; and set time, 35 psi at 30 min.

Another embodiment of the composition has use in plastering surfaces. The plaster composition has the following proportions, in vol %: plaster sand, 61.7; water, 18.8; flyash (class F), 13.7; and cement (type I-II portland), 3.8. Entrapped air accounts for 2 vol %. The water-to-cementitious ratio is 0.45, and the aggregate-to-cementitious ratio is 3.8. For batching, mixing water should be added to obtain a slump between 3 and 4 inches. The measured properties of this mix are: slump, 2–3 inches; compressive strength, 1200 psi at 28 days, brick strength, and 750 psi at 28 days, cylinder strength; unit weight, 137.0 pcf; and set time, 21 psi at 30 min.

A further embodiment of the composition has use as a slab mix. The slab mix composition has the following proportions, in vol %: sand, 39.9; water, 17.9; flyash (class F), 6.5; 3/4-in. aggregate, 26.6; and cement (type I-II portland), 7.1. Entrapped air accounts for 2 vol %. The water-to-cementitious ratio is 0.49. For batching, mixing water should be added to obtain a slump between 4 and 6 inches. The measured properties of this mix are: slump, 4–6 inches; compressive strength, 2000 psi at 28 days, cylinder strength; and unit weight, 141.7 pcf.

An additional embodiment of the composition has use as a tile mix. The tile mix composition has the following proportions, in vol %: sand, 39.9; water, 17.9; flyash (class F), 6.5; 3/8-in. aggregate, 26.6; and cement (type I-II portland), 7.1. Entrapped air accounts for 2 vol %. The water-to-cementitious ratio is 0.49. For batching, mixing water should be added to obtain a slump between 4 and 6 inches. The measured properties of

this mix are: slump, 4–6 inches; compressive strength, 2000 psi at 28 days, cylinder strength; and unit weight, 141.7 pcf.

The following table contains mix component ranges in vol % for the different embodiments of the construction material of the present invention, although these are not intended as limitations on the invention:

Mix components				
(vol %)	Wall mix	Plaster mix	Slab mix	Tile mix
Type I-II Portland cement	2.00-3.00	2.50-4.00	6.00-8.00	6.00-8.00
Class F fly ash	12.00-13.00	13.00-14.00	6.00-7.00	6.00-7.00
Silver fines	28.00-30.00			
Brown fines	28.00-30.00			
Plaster sand		60.00-62.00		
Concrete sand			38.00-40.00	38.00-40.00
3/8-in. aggregate			25.00-27.00	
3/4-in. aggregate				25.00-27.00
Water	22.00-24.00	17.00-19.00	16.00-18.00	16.00-19.00
Entrapped air	1.00-3.00	1.00-3.00	1.00-3.00	1.00-3.00

This construction composition has the characteristics of a fortified adobe material, and has a compressive strength 2–3 times that of normal adobe masonry, and 1.5 times that of pumice-crete. It is believed that the use of flyash adds strength, resistance to moisture penetration, and material flowability. Since the material is pourable integrally, there are no mortar joints. Since only a relatively small amount of cement is used in the composition, strength is not predominantly achieved by hydration, but rather by air drying.

A first embodiment of the invention includes wall structure **10** (FIGS. 1 and 2) that is set into an elongated ditch **11** in soil **12**. A frame structure comprises a plurality of spaced-apart frame elements, which in turn comprise a plurality of posts **13**, which may comprise steel fence posts or tee-type posts, although this is not intended as a limitation.

5 The posts **13** are driven into the soil **12** at the bottom of the ditch **11** to a depth of approximately 24–36 inches to form two substantially parallel rows thereof. In a particular embodiment the posts **13** are set in staggered pairs at a separation of approximately 10 to 12 inches apart and spaced 8 feet on center.

A plurality of stones **18** or rubble fill the ditch **11** around the posts **13** for providing additional support to the frame structure. The stones form a mound having a level above a level of surrounding ground toward a center of the ditch **11** of approximately 12–18 inches, the mound sloping downward toward opposed edges of the ditch **11**.

In one subembodiment a rebar top edge **19**, for example, a ½-inch bar, may be wired to the posts **13** with wire or other means. In another subembodiment the rebar **19**

15 is not present.

A support structure comprising in this embodiment a wire mesh **14**, such as a hog wire mesh, is affixed to the posts **13**, such as by wire or other means known in the art. The wire mesh **14** is affixed in covering relation to the two rows of posts **13** to form two substantially parallel mesh walls, the void therebetween forming an interior space **15** of

20 approximately 10–12 inches.

A core material **16** is positioned within the support structure's interior space **15**. In a preferred embodiment the core material **16** comprises a dried plant material such as sagebrush or straw, although this is not intended as a limitation. Other possible core materials comprise at least one of a recyclable material, such as sheared plastic, and a
5 filler-insulating material, such as air-entrapped (gunned) fibrous (paper) material. Depending upon the environment, other recyclable material may be used, such as straw. Preferably the core material **16** contains voids therein. The construction composition is also sprayed into the interior space **15** to fill at least some of the core material voids, which immediately provides lateral stability to the frame components.

10 An overlay composition **17** is applied to an exterior surface of the support structure, the overlay composition comprising the construction composition of the present invention as disclosed above. The overlay composition **17** may also be applied to the stones **18**, or they may be exposed for aesthetics. In a preferred embodiment the composition is sprayed onto an exterior surface of the wire mesh **14**. The total wall thickness ranges from
15 about 16 to about 24 inches, with a recommended thickness comprising approximately one-fourth of the height for a free-standing wall.

In a second embodiment, an exemplary wall **20**, of the invention (FIG. 3), the frame elements comprise metal bars **21** vertically affixed to a concrete footing structure **22** of a building in two substantially parallel rows. Six inches of compacted earth **220** may serve
20 as the base for the concrete footing structure **22**, which is preferably set approximately 3 feet into the ground, and has a height of approximately 1 foot.. The bars **21** may comprise, for example, rebars positioned at 2-foot centers. The frame elements further comprise first

horizontal ties **23**, each first horizontal tie **23** attached to two metal bars **21**, one metal bar **21** in each row. The horizontal ties **23** are thereby in bridging relation to the rows. Additionally, second horizontal ties **24** extend along the bar **21** rows, preferably at the top, bottom, and middle of the wall **20**.

5 The support structure comprises a mesh material **25** that is affixed in covering relation to the two rows of bars **21** to form two substantially parallel mesh walls. A void is formed between the rows of bars **21** to form the support structure's interior space, which is bridged by the first horizontal ties **23**.

10 The core material **26** in this embodiment **20** comprises the construction composition of the present invention, which is also sprayable onto the mesh material **25** to form the overlay **26** to approximately 1-inch thickness on both sides.

15 The wall **20** may support a horizontal beam **27** by use of a vertical pin **28** inserted, for example, into a predrilled hole. The beam **27** may be used to support a roof structure **29** or other element as known in the art. A floor structure **290** may also be provided made of the overlay composition, laid upon an understructure **291**.

20 In a third embodiment **30** of the invention (FIG. 4), the frame elements comprise two frame sheets **31**, each in turn comprising a pair of substantially parallel, spaced-apart beams **32**. A bottom beam **32** may comprise a base plate such as is known in the art. A plurality of post elements **33** are attached in bridging and generally perpendicular relation to each pair of beams **32** for forming the frame sheets **31**. A building element skeleton is formed by holding the two frame sheets **31** in substantially parallel relation to each other,

such as by attaching at least one end of each frame sheet **31** to a stationary object, such as the ground **34**, or by inserting spacers between and in bridging relation to the frame sheets **31**, such as horizontal bars **35**.

This embodiment **30** may be used in a structural role, and can accommodate fenestrations, electrical, and mechanical systems. A roof structure may be installed and, with minimal temporary coverings, the structure can proceed with construction during inclement conditions year round.

A wire mesh **36** is affixed in covering relation to an outward-facing side **37** of each frame sheet **31**, a void **38** between the two frame sheets **31** comprising the interior space. Insulation **39** is applied to the wire mesh **36** of at least one of the frame sheets **31**, in the form of either an insulating panel or an insulating foam sprayed onto the wire mesh **36**.

In this embodiment the core material **40** comprises the construction composition of the present invention. In this embodiment the flyash component is preferably in the range of about 3 to about 4 parts. The construction composition is also sprayable onto an outward-facing side **37** of each frame sheet to form the overlay composition **41**.

Preferably a two-stage application is performed, the first stage comprising the spraying of about 10–18 inches into the void **38**, which provides lateral stability to the frame component and additional structural performance for gravity loads. The second stage comprises spraying the exterior and interior faces of the frame sheets **31** to a thickness of approximately 1–3 inches, adding 4–6 inches total wall thickness, as well as providing an exterior finish. The total wall thickness then will comprise approximately 12–24 inches,

depending upon the requirements for the wall. The core thickness should preferably be no less than 1/12 of the bearing wall height.

The system **30** synergy can produce a wall construction system that can be employed in all seasons of the year, is built with sustainable materials, and is built expeditiously with materials that do not require extensive labor. The system **30** has improved affordability and minimizes energy consumption with respect to both the construction and the heating and cooling of the occupied building.

In yet a fourth embodiment **50** (FIG. 5), the frame elements comprise a plurality of first bars **51** arrayed in two vertical rows and a plurality of second bars **52** attached in substantially horizontal fashion along the two rows of the first bars **51**. The second bars **52** may comprise, for example, rebars. Third bars **53** span a void **54** formed by the rows of first bars **51** to secure the wall thickness, which may be in a range of 10–24 inches. The third bars **53** are positioned at, for example, 48-inch spacings along the rows of first bars **51**. In a particular use of this embodiment **50**, a fortified adobe slab is formed on an insulative pumice base **56**, and a footing **57** is formed of a rigid urethane foam, preferably having a minimum thickness of approximately 2 inches, and having a sloped exterior face. The footing **57** is covered by an insulation **58** that extends vertically through the wall **50**.

A plurality of laths **59**, preferably self-furring laths, are arrayed in two substantially parallel rows and are positioned in substantially vertical fashion, with one row along each of the two rows of first bars **51**. The first bars **51** are positioned in supporting relation to the laths **59**, to form a void between the two rows of laths **59**. Insulation **60** in the form of

either an insulating panel or a sprayable insulating foam is attached to at least some of the laths **59** of at least one of the rows of laths **59**.

In this embodiment **50** the core material **61** comprises the construction composition of the present invention, which is also sprayed **62** onto an outward-facing side **63** of the insulation **58**.

A structural roof member may be supported on a strengthened fortified adobe layer or a bond beam **64**.

In a fifth embodiment of the invention (FIG. 6), a wall **70** is formed from the frame elements comprise a plurality of posts **71** driven into soil **72** to form two substantially parallel rows. In a preferred embodiment the posts **71** comprise T-poles. A flexible bar material **73** is wrapped around the rows of posts **71** to provide reinforcement. A bar such as 3/8 rebar comprises an exemplary bar material usable for this purpose.

The support structure comprises a flexible sheathing material **74** affixed in surrounding relation to at least a bottom portion of the two rows of posts **71** to form an enclosed space **75**. In a preferred embodiment, the sheathing material **74** comprises Tex Sheathing Paper, although this is not intended as a limitation.

A wire mesh **76** is affixed in surrounding relation to the sheathing material **74**. A dried plant product such as straw **77** is used to fill the space **75**. A top **78** is formed by cutting and folding further sheathing material **74** over the filled space **75**, and further wire mesh **76** is affixed in spanning relation to the two rows of posts **71** at a top of the support structure.

Once the support structure is in place, a plastering composition **82** is sprayed onto the outward-facing sides of the support structure and to the upper surface of the wall structure top. The plastering composition **82** has been described above. Finally, the overlay composition **83** is sprayed over the plastering composition **82** to complete the wall structure **70**.

An exemplary thickness of the wall **70** of this embodiment is approximately 1 foot, for heights up to 6–10 feet.

The slab mix is usable as a floor slab and wearing surface and has been designed for placing over native soils in lieu of concrete. It is able to sustain bearing wall loads and pedestrian traffic wear. The slab mix can be placed using a ready-mix truck or pumping system, and can be made in colors.

The tile mix can be applied with a portable mixing machine or ready-mix truck.

In the foregoing description, certain terms have been used for brevity, clarity, and understanding, but no unnecessary limitations are to be implied therefrom beyond the requirements of the prior art, because such words are used for description purposes herein and are intended to be broadly construed. Moreover, the embodiments of the apparatus illustrated and described herein are by way of example, and the scope of the invention is not limited to the exact details of construction.

Having now described the invention, the construction, the operation and use of preferred embodiments thereof, and the advantageous new and useful results obtained thereby, the new and useful constructions, and reasonable mechanical equivalents thereof obvious to those skilled in the art, are set forth in the appended claims.